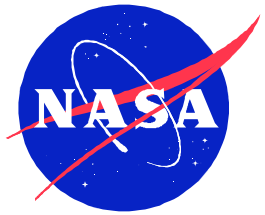

Trying Not to Build the Same Old Spacecraft: Structural and Political Issues in Design

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EARLY DRAFT

Spacecraft Design and Design Inheritance

- A spaceship is iconic of the future
- Spacecraft design requires strong inheritance from past designs
  - Expensive, complex and risky
  - Low number of prior examples and flights – Compare shuttle flights with airplane flights
- This talk discusses the social and economic factors forcing design inheritance

Slide background: Spacecraft picture

NASA's Spacefaring Plans

- Describe President's Space Vision
  - Crewed and Robotic Lunar Landings
  - Lunar Habitat
  - On to Mars
- Quote from briefing

An Anthropologist (Working) On Mars: How I'm Involved

- As part of this effort, I have been a member of two spaceship planning teams
  - Orbital Space Plane Requirements Team
    - An earlier design effort
    - I was helping to design and evaluate requirements in the areas of knowledge management, training, the human side
  - NASA Ames Crew Exploration Vehicle Team
    - Team working on developing NASA partnerships with industry
    - I was representing the area of knowledge management, particularly in Integrated Vehicle Health Management Systems

Previous Design Efforts

- The X30 series
- Orbital Space Plane
- Crew Exploration Vehicle
- Current Apollo-like architecture

Planning for the Future

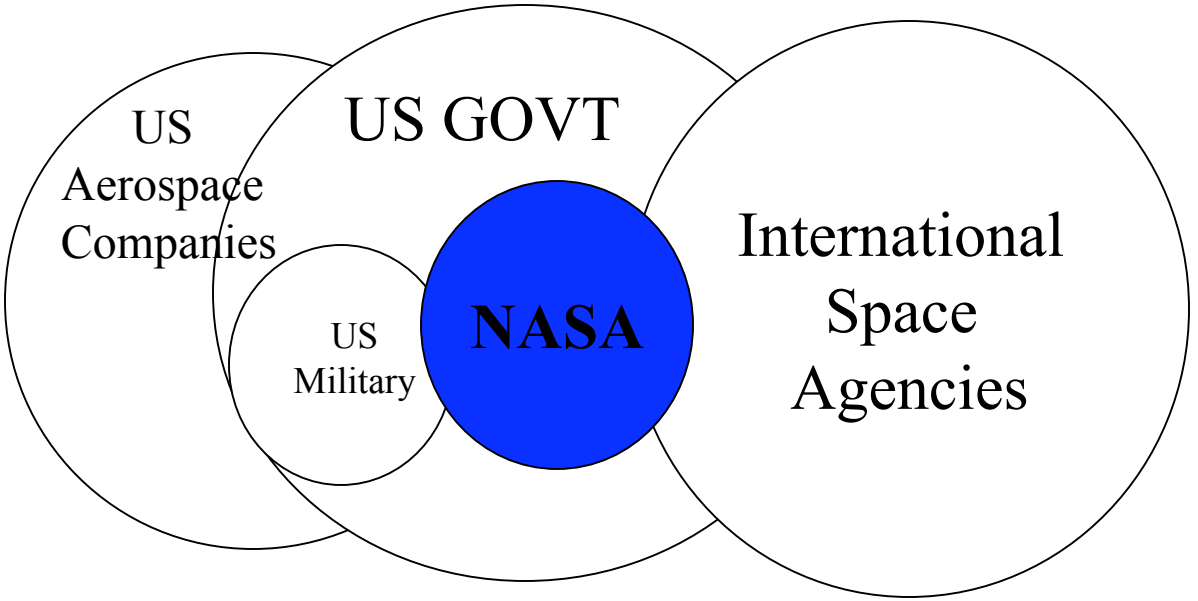
- This is a multi-decade plan
  - Can not make detailed plans for technology not yet developed
  - Plan includes “spiral development” – essentially planning to plan
    - *Definition of spiral development*

Problems of Long-term Planning

- No one wants to be responsible for the next Y2K problem
  - An obvious design flaw that could have been anticipated
- More thoughtful designers don't want to be responsible for the next QWERTY keyboard
  - A good solution for its time
  - Could be improved or replaced once new keyboard technologies are designed
  - Problem is social: an installed base of users can not be made to switch to a better design when the technology changes

Picture of designer at sketchboard with thought balloon of old typewriter

The System of AeroSpace: A NASA-Centric View



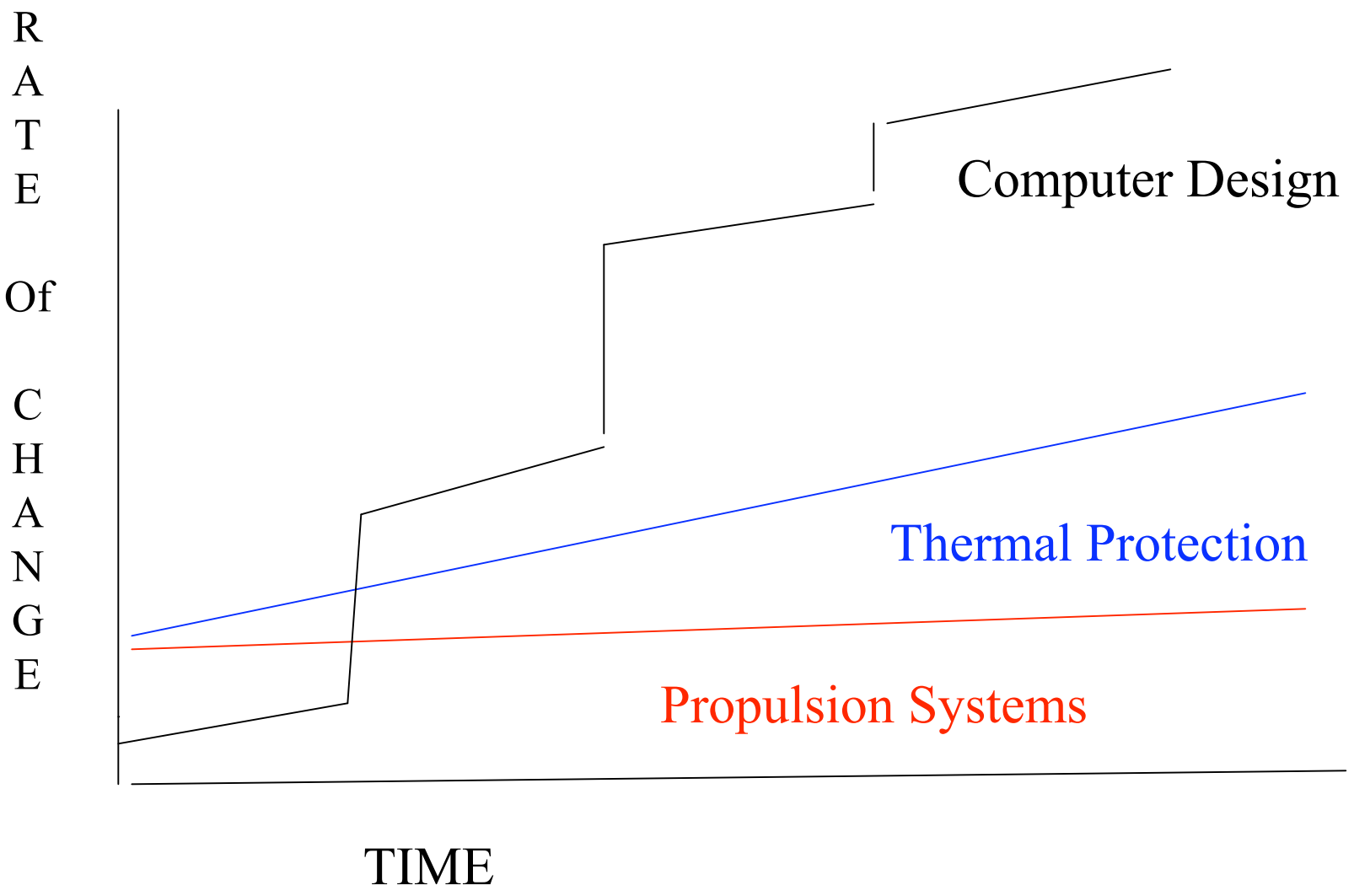
Factors Leading to Change

- Political changes
  - Funding of Apollo program
  - Faster Better Cheaper missions
- Mission demands: doing something that has never been done before
- Availability of new technologies
  - Can lead to change, but not necessarily
- Changes in risk acceptability and risk management

Factors Retarding Change

- “They got it right the first time”
- Installed technology base
- Amount of risk acceptable
  - Old technologies with known failure parameters can be preferred to possible improvements with unknown failure parameters
  - Are there social mechanisms for learning from failures?
- Length of mission (as compared to rate of change of technology)
- Rate of change within spacecraft design subsystems

Rates of Change of Technologies



Strategies for Planning to Plan

- Spiral Development
- Modeling Technologies
  - Simulation Based Acquisition
- “Sockets” and “Modularity:
  - Attempts to leave room for the insertion of not yet developed technologies
  - Do we know what these are, or is this a pious hope?

Spacecraft Design: An Ideal Site for Studying Design Inheritance

- Time involved allows for easier study
  - This is the *longue durée* of technology
- Complex interaction of technical, political and societal factors
- Spaceships are cool